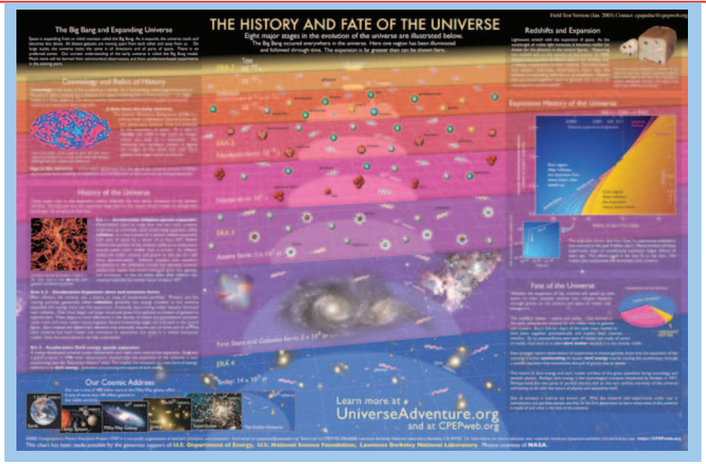
## 'The History and Fate of the Universe' Wall Chart Debuts




What time did the universe begin? When did the first star appear? How long will the universe last? A colorful, graphically rich chart that illustrates and summarizes what is now known about the history and fate of the universe has been developed by scientists at Berkeley Lab in collaboration with the Contemporary Physics Education Project (CPEP). More than 11,000 copies of this chart was distributed last month through The Physics Teacher magazine to high school science teachers across the nation for field-testing with their students.

The History and Fate of the Universe chart was first proposed about three years ago by Berkeley Lab physicists George Smoot and Michael Barnett.

"The hardest part in doing a chart like this is deciding what to include and what to exclude; the more we included the more we had to cut out," says Smoot, who is best-known for his pivotal role in the discovery of radiation ripples in the infant universe that grew into the galaxies of stars we see today.

With the help of volunteers from around the world, Smoot and Barnett were able to pack plenty of information into the History and Fate of the Universe chart, covering a broad range of cosmological topics. The centerpiece is an evolutionary timeline that takes viewers from $10^{-44}$ seconds, when the universe was much smaller than a proton, to the current era, about 14 billion years later, when the visible universe contains 4 x $10^{11}$ billion galaxies. Side panels provide short discussions on the birth, inflation and expansion of the universe, the cosmic microwave background, redshifts of distant supernovas, dark energy, dark matter, and what appears to be the ultimate fate of the universe based on what is now known.

To view the chart online, or for educators who want to participate in its field testing, go to UniverseAdventure.org.

**Science on the Hill** is produced by the Berkeley Lab Public Affairs Deparment.

Lisa Gonzales, Editor x llgonzales@lbl.gov
Community Relations: Terry Powell (510) 486-7292
Tours: Marla Morales (510)486-5183
Education Outreach: Rollie Otto (510) 486-5325

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BERKELEY LAB

# Science on the Hill

The Community Newsletter of Lawrence Berkeley National Laboratory Spring 2003


## Blueprint of Human Genome Just Beginning of Book of Life

The achievement was heralded with appropriate fanfare—the mapping of the human genome was complete. After 13 years, the complex DNA blueprint of human life was decoded, and Berkeley Lab—as a primary member of the Department of Energy's (DOE) Joint Genome Institute (JGI) in Walnut Creek—made major contributions. Three of the body's 26 chromosomes were sequenced, or mapped, there. And the whole effort really started when Berkeley, Livermore and Los Alamos labs accepted DOE's mandate to decipher the genome when no one else would. But now what? Rather than an end point, this is only a start.

Berkeley Lab's Eddy Rubin, Director of the JGI, said cracking the code "marks the beginning of an era that promises profound insights into the molecular functioning of all forms of life. Our understanding of cellular processes, the impact of organisms on each other and on the earth's environment, as well as fields of biological investigation yet to be identified, will be directly influenced by the discoveries and technologies of genomics."

DOE's Microbial Genomics and Genomes to Life programs, which will build on the data and technology developed by the Human Genome Project, will provide innovative and effective solutions to such problems as environmental cleanup and global warming, as well as new energy sources for the United States and the world.

Berkeley Lab is playing a major part in the first Genomes to Life grants—$26.1 million is coming here to start a new Virtual Institute for Microbial Stress and Survival. Adam Arkin of the Physical Biosciences Division will co-direct the institute with Terry Hazen of the Earth Sciences Division.

"Our role will be to characterize the response to environmental stress by bacteria," Arkin said. "The idea is that if bacteria will transform metal and radionuclide contaminants in waste, we won't have to treat it." Added Hazen, "Given the mind-boggling advancements that have been made in genomics and biotechnology, heralded by the Human Genome Project, it is now time for us to turn that same research drive on nuclear waste contaminated environments."

The JGI has already sequenced the genomes of a variety of microbes, marine animals, and other organisms to provide points of comparison that could shed light on the nature and functioning of the human genetic code. More such "comparative genomics" will be studied at Walnut Creek in years to come. It is all part of the plan to explore the "operating systems" of life written in those genetic codes and to put them to use.

For more information, on the Genome Project, go to www.jgi.doe.gov.

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## Big Step for Small Science

**Nanoscience–the study and manipulation of matter at the atomic scale–is a hot national field, and for Berkeley Lab a research priority. Federal funding has been proposed to construct a "molecular foundry" on site by 2006. Initial Washington commitments and University of California design approval in April brought the dream closer to reality. The facility (artist's rendition pictured here) will include a six-story building of about 86,500 gross square feet and an adjacent 8,000-square-foot central utility plant in the Lab's southeastern corner, on the hillside between the National Center for Electron Microscopy and the Materials Sciences building (66).**

**Results from nanotechnology's challenges might include inexpensive personal computers as fast as today's supercomputers, compact biological sensors for homeland security, and nanoscale drug delivery systems. Miniaturized devices and instruments will revolutionize virtually every major technology.**

## Science Education

# Local Schools Take Tours of the Lab

This spring the Lab's Center for Science and Engineering Education (CSEE) will be providing field trips to the Lab for Oakland and Berkeley public school students. In all, 12 elementary schools, 12 middle schools, and 8 high schools will be journeying up the hill for hands-on activities and demonstrations, as well as tours of our facilities and the opportunity to meet and talk with world class scientists.

In order to address the limitations of science in the classroom, CSEE has developed content for the field trips that is consistent with the State standards for the different grade levels. For the fifth graders who came to the Lab from Lafayette and Chabot Elementary Schools (left), that focus was on the structure of matter.

"It's important for children to know that scientists are real people who don't just exist in science fiction," said Edith Bourret-Courchesne of the Material Sciences and the Life Sciences Divisions who taught a lesson on semi-conductors. "This way they can begin to think of a future in science for themselves."

To learn more about the Lab's educational outreach, go to csee.lbl.gov.

## Local Resident, Global Citizen

# Lab Partners with City of Oakland to Save Energy

The California electricity crisis has receded from the headlines, but energy costs are still high in the state. As a result, Berkeley Lab is working with the City of Oakland as part of the Oakland Energy Partnership. The new partnership consists of six programs to help Oakland businesses and residents become more energy-efficient.

"The partnership will put $4 million a year in energy cost savings back in the pockets of Oakland businesses and residences," said Oakland Mayor Jerry Brown, "It will strengthen the city's economy by moving it closer to sustainability."

Scientists from Berkeley Lab's Environmental Energy Technologies Division provided the city with technical assistance in designing the programs and submitting proposals to the California Public Utilities Commission, especially in the areas of commercial building system tune-ups and street lighting.

Said Lab scientist Mary Jo Piette, "Field testing our research results provides the city with the latest and most cost-effective techniques for energy savings."

The tune-up program aims to commission 10.5 million square feet of buildings, which would result in a potential energy bill savings of $2.4 million per year. The Lab will identify the most effective energy-efficiency measures for each building.

For the full story, go to www.lbl.gov/Science-Articles/Archive/EETD-energy-partnership.html.

# A Volunteer in Swaziland

Last December, Hakeem Oluseyi of the Lab's Physics Division spent a week in Swaziland visiting schools and orphanages with an international team of science teachers from Africa and the U.S. He was part of Cosmos Education, a nonprofit group based at Stanford that taught 600 children during this trip. The Cosmos Education team—a group of students, teachers, and working scientists from Kenya, Swaziland, South Africa, and the U.S.—set out on an intensive series of presentations to local schools, orphanages, and youth rehabilitation centers.

"We wanted to make students aware of careers in science, we wanted to raise their awareness of environmental issues, and we wanted to teach them some facts about HIV and AIDS," Oluseyi says.

**Hakeem Oluseyi (center, rear) with members of the Cosmos Education team and local residents of Soweto, South Africa.**

On this trip, Oluseyi debuted the wave dance for which he soon became famous, acting out the back and forth movements of sound and the right-angle movements of light. Gyroscopes and Slinky toys were also pressed into the act, as was his cell phone during a subsequent visit as he helped a girl student call California.

"My point was that understanding the fundamental laws of physics allows us to understand many things from the way elephants communicate over many miles using very low frequency sound waves, to the way humans communicate using low frequency light, radio," Oluseyi explains.

Oluseyi returned to the United States with a new appreciation for the African people and a philosophy of science reinforced by the experience: "Everything is subject to scrutiny. You have a right to ask anyone who tells you something, how do you know that?" The answer is that "the scientific method is what we used to reconcile our observations with what we theorize."

Go to www.lbl.gov/Publications/Currents/Archive/Jan-24-2003.html#Wave for the full story.

## A WORLD OF GREAT SCIENCE AT BERKELEY LAB

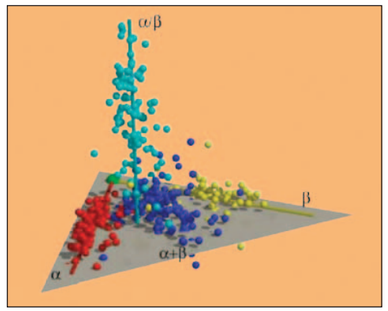
# Primates and the Human Genome

Scientists with the Joint Genome Institute (JGI) and Berkeley Lab have developed a powerful new technique for deciphering biological information encoded in the human genome, enabling scientists to make meaningful comparisons between DNA sequences in the human genome and sequences in the genomes of apes, monkeys, and other non-human primates. This will allow scientists to study biological traits that are unique to the primate family.

"The ability to compare DNA sequences in the human genome to sequences in non-human primates will enable us in some ways to better understand ourselves," says Eddy Rubin, director of the JGI and the Lab's Genomics Division, who led the research team. For example, by examining small DNA segments from 18 primates—including humans—Rubin and his colleagues were able to identify the DNA sequences that regulate a gene that is an important indicator of the risk for heart disease and is found only in primates.

To learn more about Rubin's research, go to www.lbl.gov/Science-Articles/Archive/JGI-primate-genome.html..

**Lab scientists have developed a technique to overcome the lack of distinction between the genomes of human and non-human primates. The comparative technique holds promise for biomedical research examining genes found exclusively in primates.**




**The first 3-D map of the protein universe—created by Lab researchers—shows the distribution of the 500 most common protein folds as represented by spheres.**

# The Protein Universe

The universe has been mapped! Not the universe of stars, planets, and black holes, but the protein universe, the vast assemblage of biological molecules that are the building blocks of living cells and control the chemical processes which make those cells work. Sung-Hou Kim, a chemist who holds a joint appointment with Berkeley Lab and UC Berkeley, led the development of the first three-dimensional global map of the protein structure universe. This map provides important insight into the evolution and demographics of protein structures and may help scientists identify the functions of newly discovered proteins.

"When the structure of a new protein is first solved, we can place it in the appropriate location on the map and immediately know who its neighbors are and its evolutionary history which can help us predict what its function may be," Kim says.

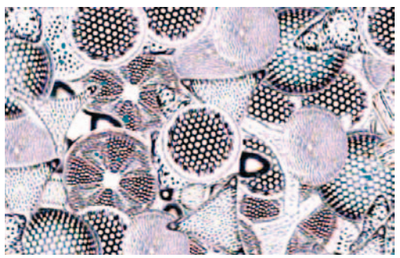
The map developed by Kim and his colleagues holds promise for a number of areas of biology and biomedical research, including the design of more effective pharmaceutical drugs that have fewer side-effects. To learm more, go to www.lbl.gov/Science-Articles/Archive/PBD-Universe-map-Kim.html.

# Squeezing the Glass Sponge

Diatomite, made from countless silica skeletons of microscopic aquatic plants, is up to 70 percent empty space. Found in important oil-bearing formations, diatomite is fragile and light enough to float on water—but so nearly impermeable that it's hard to get the oil out. For example, billions of barrels of oil lie in the diatomite formations of the Lost Hills and Belridge oilfields in central California, discovered in 1910. Yet after a century of technological development, it's estimated that less than ten percent of it can be extracted.

Now scientists and engineers from Berkeley Lab, UC Berkeley, and the ChevronTexaco Corporation are finding better ways to tap this rich but miserly mineral. Researchers in the Lab's Earth Sciences, Materials Sciences and Computer Sciences Divisions are using computer modeling and electron microscopy to develop ways of extracting more of the oil stored in low-permeability rocks without the trial and error that characterizes oil recovery today.

More about diatomite and new technologies for oil recovery can be found at enews.lbl.gov/Science-Articles/Archive/ESD-oil-in-the-rock.html.



**Sinking to the bottom of shallow lakes and seas, the glassy skeletons of unimaginable multitudes of microscopic plants formed the remarkable rock known as diatomite. Beds of this fragile rock hold billions of barrels of oil in tiny pores. Lab researchers are working on how to extract the oil out without wrecking the oilfield.**